

## **Photonic band gaps in highly conformal shell structures**

D. Gaillet, T. Yamashita and C.J. Summers

School of Materials Science & Engineering

Georgia Institute of Technology, Atlanta, GA-30332-0245, USA

Large 3D photonic band gap (PBG) materials offer revolutionary advances in controlling spontaneous emission rate and Anderson localization. Nevertheless, current techniques are not yet adequate to fabricate large area structures with optimum photonic properties. Inverse shell opals offer a bottom-up approach to fabrication but are limited by the small PBG and the lack of appropriate materials for operation in the visible where most impact is expected. We report theoretical investigations of the gap width and minimum refractive index contrast required to open a complete PBG for inverse shell opal derivatives. Backfilled geometries, achieved by growing a high refractive index material conformally on the interior surfaces of inverse shell opals, using techniques such as atomic layer deposition, are presented. A highly conformal silicon inverse non-close-packed opal that exhibits a complete PBG of 7.2% is predicted compared to 2.6% for an 86% conformally coated inverse shell opal. Also, our simulations indicate a complete PBG is sustained for refractive indices greater than 2.9 compared to 3.3. Furthermore, it is predicted that for a theoretical structure in which, prior to backfilling, 97.7% of the interstitial volume is conformally coated, should support a 16% complete PBG and a lower refractive index requirement of 2.55. These novel PBG structures would allow operation in the visible using lower refractive index materials.